

## FOOD HABITS OF THE GREAT HORNED OWL (*BUBO VIRGINIANUS*) IN A PATAGONIAN STEPPE IN ARGENTINA

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**ABSTRACT.**—We studied seasonal variation in the diet of the Great Horned Owl (*Bubo virginianus*) through pellet analysis. Pellets were collected every month during 1995–96 from a steppe area in northwest Patagonia, Argentina. We identified 1216 prey items in 522 pellets. Rodents accounted for 98.5% of the diet while the remainder consisted of a variety of birds and insects. Rodents most frequently found in pellets were *Eligmodontia morgani*, *Abrothrix longipilis*, *A. xanthorhinus*, *Oligoryzomys longicaudatus*, *Reithrodon auritus*, and *Ctenomys haigi*. In terms of biomass, the most important species were *R. auritus*, *A. longipilis*, *C. haigi*, and *E. morgani*. Food-niche breadth was greatest in winter. Within the study area, the Great Horned Owl should be considered to be a rodent specialist all year round.

**KEY WORDS:** Great Horned Owl; *Bubo virginianus*; diet; rodents; Patagonia.

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Hábitos alimentarios del *Bubo virginianus* en un área esteparia del noroeste de la Patagonia Argentina

**RESUMEN.**—Se estudió estacionalmente la dieta de *Bubo virginianus* mediante el análisis de egagrópilas recolectadas mensualmente durante los años 1995 y 1996, en un área esteparia del noroeste de la Patagonia Argentina. Fueron analizadas 522 egagrópilas que contenían 1216 presas. El 98.5% de las presas eran roedores, mientras que el 1.5% restante eran principalmente aves e insectos. Entre los roedores consumidos se encontraron en mayor número ejemplares de *Eligmodontia morgani*, *Abrothrix longipilis*, *A. xanthorhinus*, *Oligoryzomys longicaudatus*, *Reithrodon auritus* y *Ctenomys haigi*. En términos de biomasa, las mayores contribuciones corresponden a *R. auritus*, *A. longipilis*, *C. haigi* y *E. morgani*. La amplitud trófica alcanza el valor máximo en el invierno. En el área estudiada *B. virginianus* puede considerarse un especialista en roedores durante todo el año.

[Traducción de Autores]

The Great Horned Owl (*Bubo virginianus*) is distributed widely throughout the Americas and it lives in a variety of different habitats (Burton 1992). Its food habits have been studied at many different sites in North America. In South America, several quantitative studies have been carried out in Chile (Jaksic et al. 1978, Yáñez et al. 1978, Jaksic and Yáñez 1980, Jaksic and Marti 1984, Jaksic et al. 1986, Iriarte et al. 1990) and Argentina (Donázar et al. 1997). Marti et al. (1983) reviewed studies of the owl's diet in North and South America. Most of these studies reported Great Horned Owls mainly preying on rodents and lagomorphs, although there were regional, seasonal, yearly and long-term differences in diet.

Our study analyzed the food habits of the Great Horned Owl in a steppe area in northwest Patagonia, Argentina, and described the seasonal

changes in diet composition and food-niche breadth over two years (1995–96).

### STUDY AREA AND METHODS

Our study was conducted in northwest Patagonia, east of the city of Bariloche, Argentina (41°08'–41°08'45"S, 71°12'–71°13'20"W). The study site was located in a steppe area of the transition zone between the subantarctic forests and the Patagonian steppe. The area is dominated by bunchgrasses such as *Stipa speciosa* and *Acaena splendens* and scattered bushes (*Senecio filaginoides*, *Baccharis linearis*, *Colletia hystrix* and the exotic species *Rosa rubiginosa*). A road lined by exotic conifers (*Pinus* spp. and *Cupressus* spp.) ran through the area. These trees provide roosts for the Great Horned Owl.

The small mammal community in the area has been studied by Guthmann (1996) and Guthmann et al. (1997). According to them, the fauna consists of representatives of forest and steppe species dominated by *Eligmodontia morgani*, *Reithrodon auritus* and *Abrothrix xanthorhinus*, which are typical of semiarid steppe. *A. longipilis*

inhabits areas of dense forest to bushy steppe, and *Oligoryzomys longicaudatus* is abundant in brush areas and the edges of forests (Pearson 1995). Smaller numbers of *Loxodontomys micropus* inhabit humid or mesic brushy habitats, and *Ctenomys haigi* inhabits open areas with sandy soils (Pearson 1995). There were so far no records of other nocturnal raptor species within the study site, although Barn Owls (*Tyto alba*) were probably in the area.

Owl roosts were located by observing areas of white-wash or recording places where pellets were found. Pellets were collected monthly from February 1995–November 1996 at six known roost sites. Pellets were air dried and their length and width was measured with an electronic caliper to the nearest 0.01 mm. The pellets were dissected using standard techniques (Yalden 1990). Variations in measurements were related to the number of prey contained in the pellets by means of a one-way ANOVA. Prey biomass was calculated only for rodents. Mass estimates for each prey taxon were either determined from individuals captured in the study area or taken from literature.

Prey were identified to the finest possible taxonomic level. Mammalian prey were identified and quantified on the basis of skulls and dentary pairs using reference collections and keys (Pearson 1995). Insects were quantified by counting head capsules and mandibles. For other prey items, reference collections were used and they were quantified by assuming minimum number of individuals (e.g., feathers or scales of a given species were deemed to represent only one individual). Diet composition was compared between seasons and years with chi-square and G tests.

The contribution of each rodent species to the biomass of the owls' diet was calculated by multiplying mean body mass of individuals by number of individuals in the pellets. Values were expressed as a percentage of total rodent biomass consumed.

Food-niche breadth (FNB) was estimated using Levins' (1968) index:  $FNB = 1/(\sum p_i^2)$ , where  $p_i$  is the proportion of prey taxon  $i$  in the diet. A standardized-niche breadth value (FNB<sub>st</sub>) was calculated, which ranged from 0 to 1:  $FNB_{st} = (FNB - 1)/(n - 1)$ , where  $n$  is the total number of prey categories (Colwell and Futuyma 1971). Evenness of prey numbers was measured using the Shannon-Wiener function  $J'$  (Krebs 1989):  $J' = H'/\log n$ , where  $H'$  is the Shannon-Wiener formula and  $n$  is the total number of prey categories.

## RESULTS

A total of 1216 prey items was identified from 522 pellets. The mean number of prey/pellet was 2.3 (SD = 1.1; range = 1–7). Pellet measurements ranged from 2.3–8.8 cm long ( $\bar{x} = 4.5$ ; SD = 1.1;  $N = 516$ ) and from 1.4–4.3 cm wide ( $\bar{x} = 2.7$ ; SD = 0.4;  $N = 516$ ). Significant differences ( $P < 0.05$ ) were found for both length ( $F = 17.365$ ,  $df = 4,507$ ) and width ( $F = 20.365$ ,  $df = 4,506$ ) and they appeared to be related to the number of prey in each pellet.

Rodents accounted for 98.5% of the prey (Table

1). The remaining 1.5% consisted of birds, insects, one lizard, and one lagomorph (a young *Lepus* about 0–6 months old according to cranial sutures described by González [1993]). We found one individual each of the following birds in the diet: *Tachycineta leucopyga*, *Troglodytes aedon*, *Sicalis luteola*, *Zonotrichia capensis*, *Anthus sp.*, and one unidentified Furnariidae. Insects that could be identified were Coleopterans (one of them Scarabaeidae) and Lepidopterans.

Great Horned Owls preyed mainly on *Eligmodontia morgani* over both years of the study, followed by *Abrothrix longipilis*, *A. xanthorhinus*, *Oligoryzomys longicaudatus*, *Reithrodon auritus*, *Ctenomys haigi*, and *Loxodontomys micropus*. The number of rodents consumed varied seasonally and was lower during winter. There were significant differences between the number of prey of different species eaten in 1995 and 1996 ( $\chi^2 = 14$ ,  $df = 6$ ,  $P < 0.05$ ). The greatest difference between the two years was the lower than expected consumption of *L. micropus* and *O. longicaudatus* in 1996. There were no significant differences in the number of different species consumed between winters ( $\chi^2 = 10.01$ ,  $df = 6$ ,  $P < 0.05$ ), but consumption of prey did differ significantly between summers ( $\chi^2 = 35.93$ ,  $df = 6$ ,  $P < 0.05$ ), autumns ( $G = 29.64$ ,  $df = 6$ ,  $P < 0.05$ ) and springs ( $\chi^2 = 33.74$ ,  $df = 6$ ,  $P < 0.05$ ).

The mean weight of rodent prey ranged from 15.3 g for *A. xanthorhinus* to 146.2 g for *C. haigi* (Table 2). *R. auritus*, *C. haigi* and *E. morgani* contributed most to the prey biomass and all three were consumed in a greater proportion in 1996 than in 1995. In the pellets collected during 1995, the proportion of *R. auritus* in the diet fell considerably in spring, while that of *A. longipilis* and *C. haigi* rose.

Food-niche breadth was greatest in winter and smallest in spring during both 1995 and 1996. Although the number of prey types was highest in spring, evenness was lower than in winter (Table 1). The standardized-niche breadth calculated for the two years (FNB<sub>st</sub> = 0.202) was slightly lower than for breeding seasons (spring and summer) for both years (FNB<sub>st</sub> = 0.218,  $N = 4$ ).

## DISCUSSION

Because of their small size, Great Horned Owls that occur in southern South America have been placed in their own subspecies (*B. v. magellanicus*, Traylor 1958) and it has even been suggested that they in fact belong to their own species (*Bubo ma-*

Table 1. Seasonal diet of Great Horned Owls in northwestern Patagonia, Argentina. *N* = number of prey in each taxon; % calculated over the total number of prey for each.

| PREY TYPE                     | 1995     |      |          |      |          |      |          |      |
|-------------------------------|----------|------|----------|------|----------|------|----------|------|
|                               | SUMMER   |      | AUTUMN   |      | WINTER   |      | SPRING   |      |
|                               | <i>N</i> | %    | <i>N</i> | %    | <i>N</i> | %    | <i>N</i> | %    |
| <b>MAMMALS</b>                |          |      |          |      |          |      |          |      |
| Rodents                       |          |      |          |      |          |      |          |      |
| Muridae                       |          |      |          |      |          |      |          |      |
| <i>Abrothrix longipilis</i>   | 7        | 5.8  | 10       | 11.1 | 40       | 14.5 | 97       | 35.9 |
| <i>Abrothrix xanthorhinus</i> | 7        | 5.8  | 1        | 1.1  | 32       | 11.6 | 12       | 4.4  |
| <i>Eligodontia morgani</i>    | 39       | 32.5 | 19       | 21.1 | 70       | 25.5 | 58       | 21.5 |
| <i>Loxodontomys micropus</i>  | 2        | 1.7  | 10       | 11.1 | 12       | 4.4  | 10       | 3.7  |
| <i>Chelemys macronyx</i>      | —        | —    | —        | —    | —        | —    | 1        | 0.4  |
| <i>Reithrodon auritus</i>     | 25       | 20.8 | 24       | 26.7 | 60       | 21.8 | 9        | 3.3  |
| <i>Oligoryzomys</i>           | 27       | 22.5 | 18       | 20.0 | 25       | 9.1  | 43       | 15.9 |
| <i>Geoxus valdivianus</i>     | —        | —    | —        | —    | —        | —    | —        | —    |
| <i>Irenomys tarsalis</i>      | —        | —    | —        | —    | —        | —    | —        | —    |
| Unidentified                  | 7        | 5.8  | 5        | 5.6  | 30       | 10.9 | 21       | 7.8  |
| Ctenomyidae                   |          |      |          |      |          |      |          |      |
| <i>Ctenomys haigi</i>         | 3        | 2.5  | 4        | 4.4  | 6        | 2.2  | 15       | 5.6  |
| Lagomorphs                    |          |      |          |      |          |      |          |      |
| <i>Lepus europaeus</i>        | —        | —    | —        | —    | —        | —    | —        | 0.0  |
| <b>BIRDS</b>                  |          |      |          |      |          |      |          |      |
| Passeriformes                 | 1        | 0.8  | —        | —    | —        | —    | 2        | 0.8  |
| <b>REPTILES</b>               |          |      |          |      |          |      |          |      |
| <i>Liolaemus</i> sp.          | —        | —    | —        | —    | —        | —    | —        | —    |
| <b>INSECTS</b>                |          |      |          |      |          |      |          |      |
|                               | 2        | 1.7  | —        | —    | —        | —    | 2        | 0.7  |
| <b>SPIDERS</b>                |          |      |          |      |          |      |          |      |
|                               | —        | —    | —        | —    | —        | —    | —        | —    |
| Total prey                    | 120      |      | 90       |      | 275      |      | 270      |      |
| Total pellets                 | 42       |      | 37       |      | 130      |      | 114      |      |
| FNBst                         | 0.446    |      | 0.667    |      | 0.672    |      | 0.308    |      |
| <i>J'</i>                     | 0.773    |      | 0.880    |      | 0.892    |      | 0.700    |      |

FNBst = food-niche breadth measured with standardized Levins' index (see text for explanations).

*J'* = preys number evenness by Shannon-Wiener function.

*gellanicus*, König et al. 1996). Owing to their small size, the average length and width of their pellets are among the smallest reported for Great Horned Owls. Yáñez et al. (1978) studied Great Horned Owl pellets from two regions in Chile, and found that those that contained remains of rodents were significantly wider than those containing arthropods. We could not verify this relationship in our study because the pellets contained almost exclusively rodents. Nevertheless, we did find that, in terms of the number of prey contained in pellets, there was less variation in pellet width than length. This could have been related to the fact that the

gape of the owls limited the size of the pellets they regurgitated. The low correlation between biomass and size of pellets could be a consequence of estimating biomass as average prey weight, without considering that the predator might select the size of its prey.

Studies in Chile (Yáñez et al. 1978, Jaksic et al. 1986, Iriarte et al. 1990) have found that, in some seasons, Great Horned Owls eat birds, insects, arachnids, and lagomorphs (up to 17% in Torres del Paine National Park [Iriarte et al. 1990]). In our study, these prey made up a negligible part of the diet. Near Junín de los Andes, Argentina, Don-

Table 1. Extended.

| 1996   |      |        |      |        |      |        |      |       |      |
|--------|------|--------|------|--------|------|--------|------|-------|------|
| SUMMER |      | AUTUMN |      | WINTER |      | SPRING |      | TOTAL |      |
| N      | %    | N      | %    | N      | %    | N      | %    | N     | %    |
| 49     | 25.0 | 12     | 14.5 | 11     | 15.7 | 31     | 27.4 | 257   | 49.2 |
| 25     | 12.8 | 3      | 3.6  | 11     | 15.7 | 7      | 6.2  | 98    | 18.8 |
| 59     | 30.1 | 31     | 37.2 | 16     | 22.9 | 23     | 20.4 | 315   | 60.3 |
| 3      | 1.5  | —      | —    | —      | —    | 4      | 3.5  | 41    | 7.9  |
| —      | —    | —      | —    | —      | —    | —      | —    | 1     | 0.2  |
| 19     | 9.7  | 6      | 7.2  | 10     | 14.3 | 21     | 18.6 | 174   | 33.3 |
| 17     | 8.7  | 9      | 10.8 | 7      | 10.0 | 7      | 6.2  | 153   | 29.3 |
| —      | —    | 1      | 1.2  | —      | —    | —      | —    | 1     | 0.2  |
| —      | —    | —      | —    | —      | —    | 1      | 0.9  | 1     | 0.2  |
| 12     | 6.1  | 16     | 19.3 | 8      | 11.4 | 10     | 8.8  | 109   | 20.9 |
| 6      | 3.1  | 5      | 6.0  | 5      | 7.1  | 3      | 2.7  | 47    | 9.0  |
| —      | —    | —      | —    | 1      | 1.4  | —      | —    | 1     | 0.2  |
| 2      | 1    | —      | —    | 1      | 1.4  | —      | —    | 6     | 1.2  |
| —      | —    | —      | —    | —      | —    | 1      | 0.9  | 1     | 0.2  |
| 2      | 1.0  | —      | —    | —      | —    | 4      | 3.6  | 10    | 2.0  |
| —      | —    | —      | —    | —      | —    | 1      | 0.9  | 1     | 0.2  |
| 196    |      | 83     |      | 70     |      | 113    |      | 1216  |      |
| 73     |      | 33     |      | 39     |      | 54     |      | 522   |      |
| 0.394  |      | 0.429  |      | 0.672  |      | 0.376  |      | 0.202 |      |
| 0.746  |      | 0.794  |      | 0.885  |      | 0.764  |      | 0.597 |      |

ázar et al. (1997) found the diet of Great Horned Owls consisted of 11.9% *Lepus europaeus* and 27.3% arthropods but, in terms of biomass, the two main prey items (55.2% of total prey) were juveniles of introduced lagomorphs (*L. europaeus* and *Oryctolagus cuniculus*).

Lagomorphs are considered to be the best prey for horned owls because their large body mass best suits the daily energy requirements of owls (Donázar et al. 1989). In our study, the number of lagomorphs in the diet was remarkably low despite the apparent abundance of *L. europaeus* in the area (7–12 individuals/ha, Novaro et al. 1992). According to Jaksic (1986), this situation is common for small

mammal predation in shrublands and grasslands of southern South America, with predators hunting mainly the most abundant native rodents, sometimes “ignoring” dense populations of introduced lagomorphs.

The proportion of lagomorphs we found in the diet did not support the generalization by Donázar et al. (1997) that lagomorphs represent 15% by number of the diet of Great Horned Owls in Argentine Patagonia. However, our results reinforce their explanation for the low frequency of lagomorphs in the diet of Patagonian Great Horned Owls as compared to horned owls at similar latitudes in the northern hemisphere, where they

Table 2. Biomass of rodents in Great Horned Owl diets in Argentina expressed as a percent of the total biomass of rodents consumed in each season. Mean prey weights were obtained from Pearson (1983) for *C. macronyx*, *G. valdivianus* and *I. tarsalis*; from Pearson (pers. comm.) for *C. haigi*, and from Trejo (unpubl. data) for the remaining species.

| PREY      | ABL  | ABX  | ELI  | LOX  | CHE  | REI  | OLI  | GEO  | IRE  | CTE   |
|-----------|------|------|------|------|------|------|------|------|------|-------|
| 1995      |      |      |      |      |      |      |      |      |      |       |
| Summer    | 5.2  | 2.8  | 17.1 | 3.0  | —    | 42.2 | 18.1 | —    | —    | 11.6  |
| Autumn    | 7.5  | 0.4  | 8.4  | 15.0 | —    | 40.9 | 12.2 | —    | —    | 15.6  |
| Winter    | 12.8 | 5.6  | 13.2 | 7.7  | —    | 43.5 | 7.2  | —    | —    | 10.0  |
| Spring    | 32.6 | 2.2  | 11.5 | 6.7  | 0.8  | 6.9  | 13.1 | —    | —    | 26.2  |
| 1996      |      |      |      |      |      |      |      |      |      |       |
| Summer    | 25.4 | 7.0  | 18.0 | 3.1  | —    | 22.3 | 8.0  | —    | —    | 16.2  |
| Autumn    | 14.9 | 2.0  | 22.7 | —    | —    | 16.9 | 10.1 | 1.2  | —    | 32.2  |
| Winter    | 13.5 | 7.3  | 11.6 | —    | —    | 27.9 | 7.8  | —    | —    | 31.9  |
| Spring    | 24.3 | 3.0  | 10.7 | 6.3  | —    | 37.4 | 5.0  | —    | 1.2  | 12.2  |
| TOTAL %   | 18.9 | 3.9  | 13.7 | 6.0  | 0.2  | 29.0 | 10.2 | 0.1  | 0.1  | 18.0  |
| Prey mean | 28.1 | 15.3 | 16.6 | 56.2 | 66.8 | 63.8 | 25.4 | 27.8 | 41.3 | 146.2 |

ABL, *Abrothrix longipilis*; ABX, *Abrothrix xanthorhinus*; ELI, *Eligmodontia morgani*; LOX, *Loxodontomys micropus*; CHE, *Chelemys macronyx*; REI, *Reithrodon auritus*; OLI, *Oligoryzomys longicaudatus*; GEO, *Geoxus valdivianus*; IRE, *Irenomys tarsalis*; CTE, *Ctenomys haigi*.

weigh on average 30–40% more. Donázar et al. (1997) suggested that the large size of adult lagomorphs could constrain Patagonian horned owls from preying on them, while large rodents and young lagomorphs may be more easily handled.

*E. morgani*, the mouse consumed most frequently numerically and whose biomass had least seasonal variation, would not seem to be a profitable prey due to its low weight (20 g). The energetic cost of capturing and handling these mice may exceed the actual gains (Jaksic and Marti 1984). Nevertheless, *E. morgani* was abundant in the area (Guthmann 1996) and vulnerable, the two conditions that Jaksic and Marti (1984) consider appropriate for such small prey to be included in the diet of *Bubo* owls. It is easy to catch because it inhabits sites with little plant cover or bare ground and it runs in the open for prolonged periods (Trejo pers. obs.). The prey that supplied the greatest biomass in our study was *Reithrodon* spp. According to Pearson (1988), its nocturnality, long hours of feeding, open habitat, and unwary behavior seem to expose it to predation by owls and other nocturnal predators. *Ctenomys haigi*, the largest rodent in the area, was eaten in low numbers likely due to its fossorial habits. *O. longicaudatus* and *L. micropus*, which inhabit areas covered by bushy vegetation, are scansorial (Pearson 1983, 1995), which could facilitate their detection and capture by owls.

Although only one specimen each of *Irenomys tar-*

*salis*, *Chelemys macronyx* and *Geoxus valdivianus* were found in the pellets, their occurrence was noteworthy because none of them were captured during the three years over which Guthmann (1996) systematically trapped rodents at the same site where we collected pellets. All three species are typical of the forest and environments with high plant coverage (Pearson 1983, 1995). Their occurrence in the diet indicated that they may have been present in the area in low numbers, or perhaps the fossorial habits of *G. valdivianus* and *C. macronyx* made them difficult to capture.

There was seasonal variation in food-niche breadth. Both the overall food-niche and breeding season (spring and summer) food-niche breadths were similar to those calculated by Donázar et al. (1997) in their study in Junín de los Andes. They estimated a standardized food-niche breadth of 0.20 for the breeding season. Jaksic et al. (1986) found that the horned owl diet breadth in Chile declined from north to south based on standardized food-niche breadth measurements obtained for three Chilean locations at different latitudes: La Dehesa, 33°21'S (FNB<sub>st</sub> = 0.66), Puerto Ibáñez, 46°18'S (FNB<sub>st</sub> = 0.62) and Torres del Paine, 51°S (FNB<sub>st</sub> = 0.24). However, the FNB<sub>st</sub> = 0.20 obtained both for Junín de los Andes (39°30'–40°20'S, 70°30'–71°30'W, Donázar et al. 1997) and for Bariloche (41°08'S, present study) does not fit within the latitudinal trends proposed for Chile.

The  $FNB_{st} = 0.60$  obtained by Iriarte et al. (1990) for Torres del Paine is also at odds with the proposed latitudinal trend. Considering the seasonal fluctuations in the composition of the diet, comparisons between different locations should probably be done using data from the same time of year.

In our study, the five species most consumed by horned owls had minimum population levels in winter, while in other seasons they reached peak numbers (Guthmann et al. 1997). This would explain the increase of the food-niche breadth in winter caused by the greater evenness, since the availability of all prey species.

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